

An Automated Flying-Insect-Detection System

Real-time monitoring and early detection networks for the detection of harmful flying insects.

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An automated flying-insect-detection system (AFIDS) was developed as a proof-of-concept instrument for real-time detection and identification of flying insects. This type of system has use in public health and homeland security decision support, agriculture and military pest management, and/or entomological research.

As shown in figure 1 (top panel), insects are first lured into the AFIDS integrated sphere by insect attractants. Once inside the sphere, the insect's wing beats cause alterations in light intensity that is detected by a photoelectric sensor. Following detection, the insects are encouraged (with the use of a small fan) to move out of the sphere and into a designated insect trap where they are held for taxonomic identification or serological testing. The acquired electronic wing beat signatures are pre-processed (Fourier transformed) in real-time to display a periodic signal. These signals are sent to the end user where they are graphically displayed as shown in figure 1 (bottom panel). All AFIDS data are pre-processed in the field with the use of a laptop computer equipped with LABVIEWTM. The AFIDS software can be programmed to run continuously or at specific time intervals when insects are prevalent.

A special DC-restored transimpedance amplifier reduces the contributions of low-frequency background light signals, and affords approximately two orders of magnitude greater AC gain than conventional amplifiers. This greatly increases the signal-to-noise ratio and enables the detection of small changes in light intensity. The AFIDS light source consists of high-intensity Al GaInP light-emitting diodes (LEDs). The AFIDS circuitry minimizes brightness fluctuations in the LEDs and when integrated with an integrating sphere, creates a diffuse uniform light field. The insect wing beats isotropically scatter the diffuse light in the sphere and create wing beat signatures that are detected by the sensor. This configuration minimizes variations in signal associated with insect flight orientation.

Preliminary data indicate that AFIDS has sufficient sensitivity and frequency-measuring capability to differentiate between males and females, in mosquitoes (Figure 1, bottom panel) and fruit flies (data not shown). Similar studies show that AFIDS can be utilized to detect

discrete differences between two mosquito species, *Aedes aegypti* and *Aedes albopictus*.

When fully deployable, a wireless network of AFIDS monitors could be used in combination with other remotely sensed data and visually displayed in a geographic information system to provide real-time surveillance (Figure 2). More accurate and sensitive insect population forecasts and effective rapid response and mitigation of insect issues would then be possible.

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figure captions:

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Figure 1. **The Automated Flying Insect Detection System (AFIDS):** (Top panel) Schematic Diagram of the Deployable AFIDS; (Bottom panel) Spectral Plots of AFIDS Acquired Wing-Beat Signatures: clear differences between female (plot A, 409 Hz) and male (plot B, 737 Hz) *Aedes albopictus* mosquitoes are apparent.

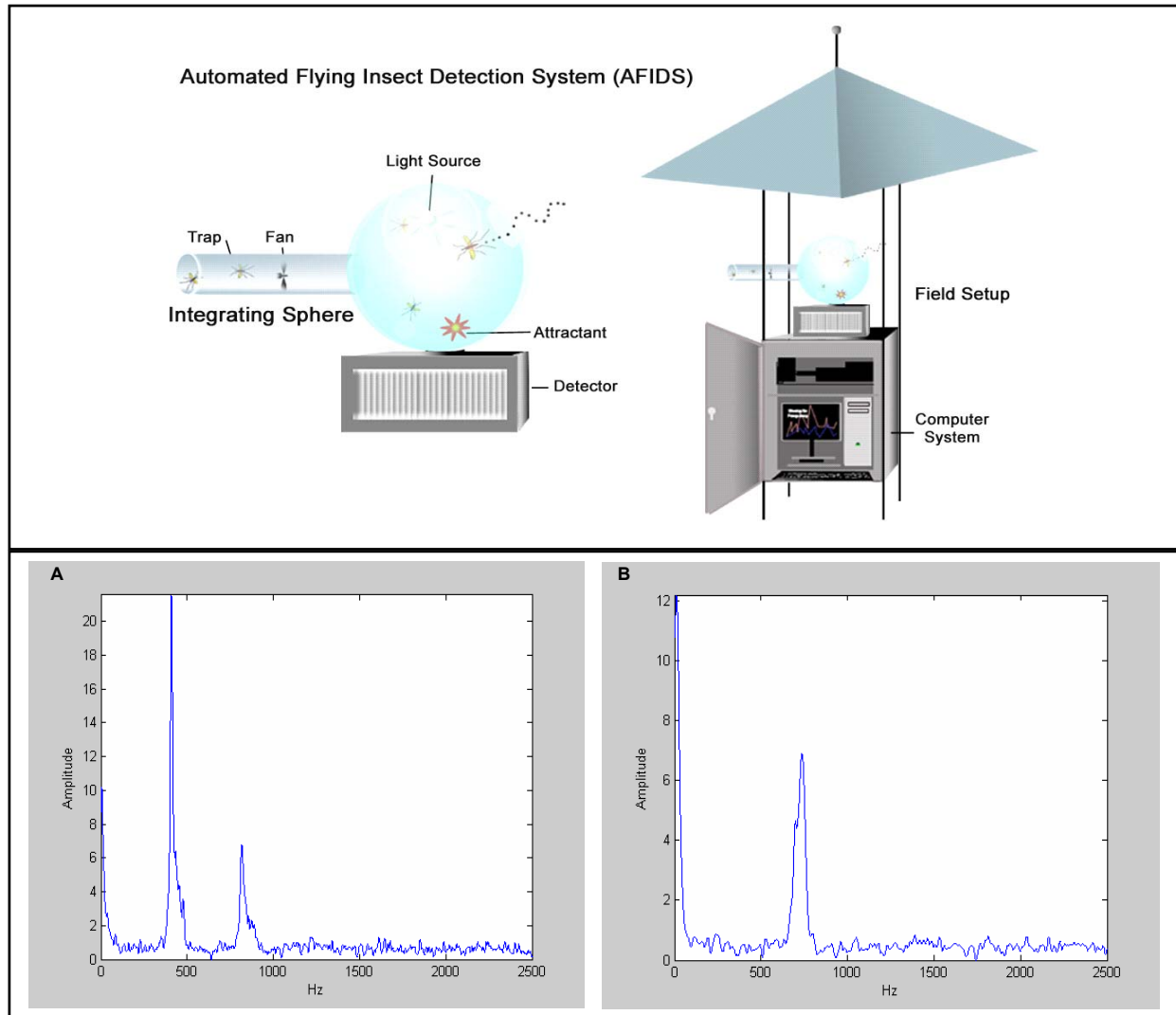


Figure 2. **Integration of AFIDS and GIS Data Layers** for Military, Civilian or Agricultural Pest Management: (Hypothetical Case). Data Layers: (1) Hypothetical AFIDS Insect Density Contours (Histograms = Threat Intensity); (2) Star 3i Radar Imagery; (3) Aster Normalized Difference Vegetative Index; (4) Lidar Digital Terrain.

